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Development of a diagnostic for ultra-intense laser plasma experiments based on frequency resolved optical gating

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Laser pulses of the highest intensities interact with sub-micrometer targets in conditions where hole boring and relativistic effects play a predominant role. These effects imprint a strong signature of the light being either transmitted or reflected by such targets. To fully understand the dynamics of the interaction, it is desirable to spectrally and temporally resolve the resulting pulses.

In this contribution, we report on the development of a time-resolved diagnostic setup for high intensity laser plasma experiments at the petawatt-class laser facility PHELIX. The diagnostics are integrated in the target area to measure both back-reflected and transmitted parts of the laser pulse. For this purpose, we use two specifically designed single-shot second-harmonic frequency-resolved optical gating systems.

The diagnostics are designed for typical experiments, where the spectral bandwidth of back-reflected pulses is broadened to 30 nm and above. The FROG achieves a spectral resolution in the sub-nanometer range and the temporal window of 10 ps is sufficient to characterize pulse durations up to 2 ps (FWHM), with a temporal resolution of 20-50 fs, depending on the system. The setup for characterizing the back-reflected pulses is permanently installed at the PHELIX target area, whereas the diagnostic for transmitted pulses can be optionally set up. Both FROGs have been characterized and tested off-line prior to installation and commissioning.

They yield a full characterization in amplitude and phase of the laser pulses and therefore can be used to study effects like laser-hole boring or relativistic self phase modulation, which are important features of laser-driven particle acceleration experiments.

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